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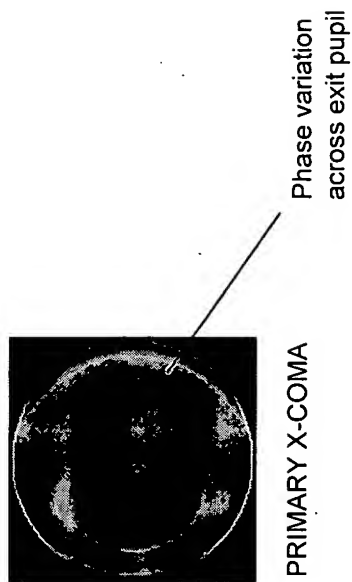
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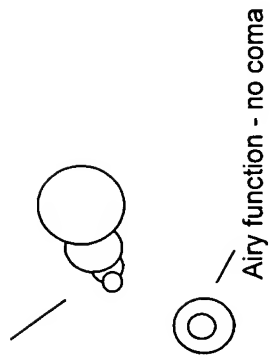
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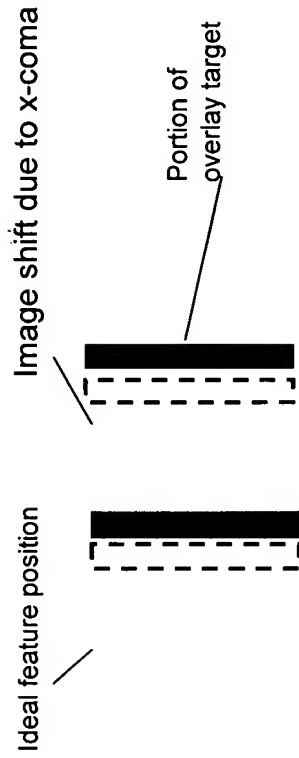
Figure 1a Phase Plot Showing Coma Aberration



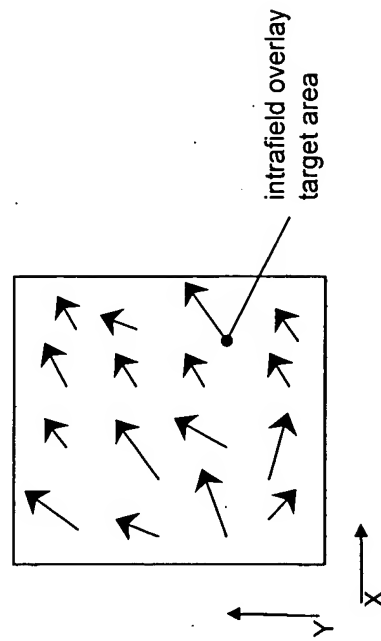
**Figure 1b** Pin Hole Image in the Presence of Coma



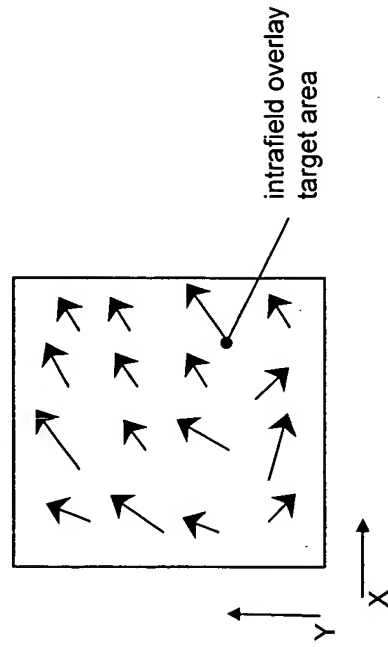
**Figure 1d** Shifting Effects of x-coma on Vertical, Large Feature Patterns



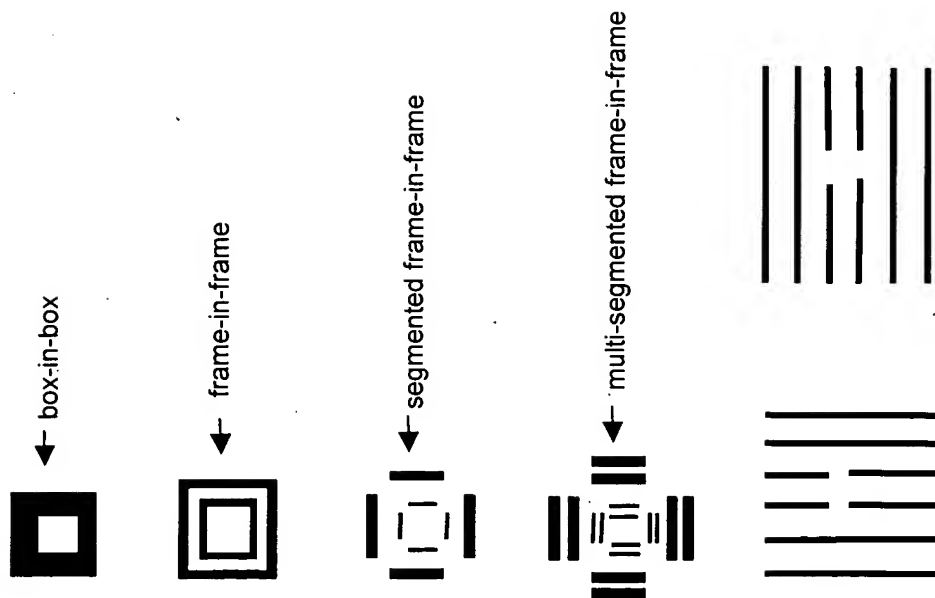
**Figure 1c** Lens Distortion - Coma and Tilt Contributions - Where, Vectors Represent Overlay Error



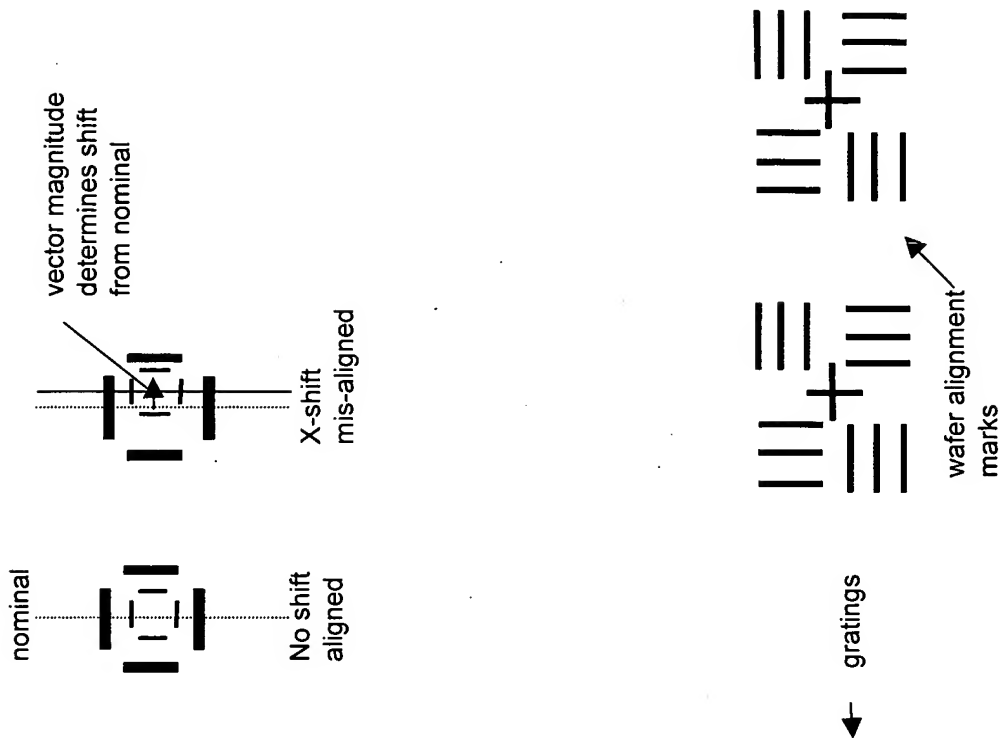
**Figure 1e** Lens Distortion - Coma Effects Removed



**Figure 2a** Typical Overlay Patterns or Completed Alignment Attributes



**Figure 2b** Typical Overlay Coordinate System with Vector Off-set for Segmented Overlay Target



**Figure 3** Quadrapole, Annular, and Conventional Coordinate Definitions

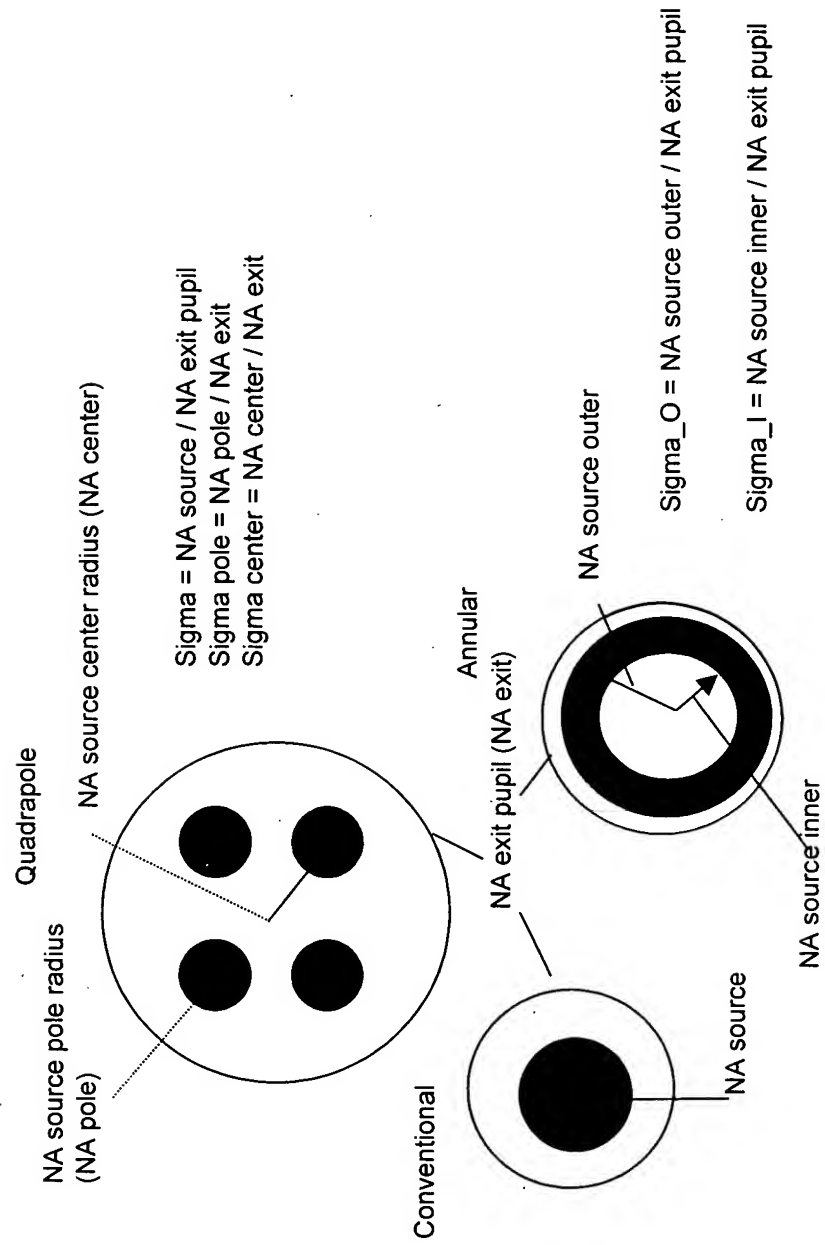
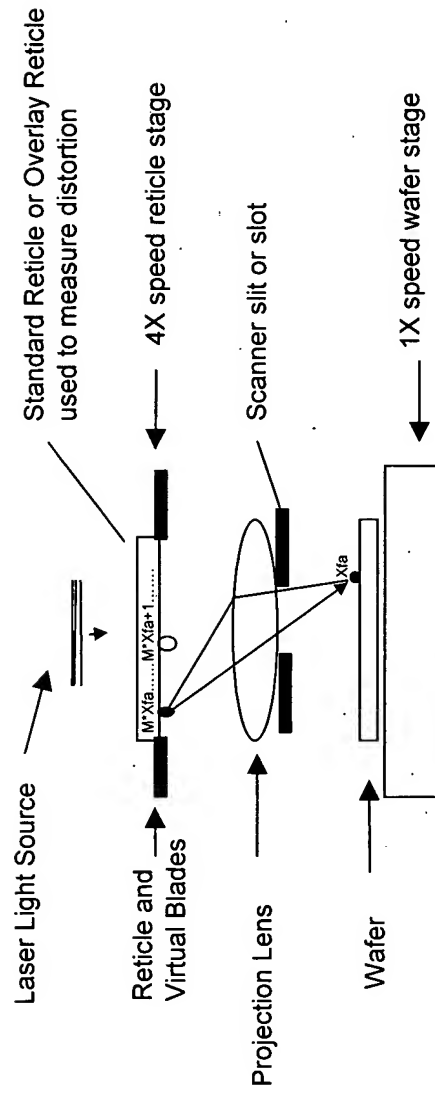
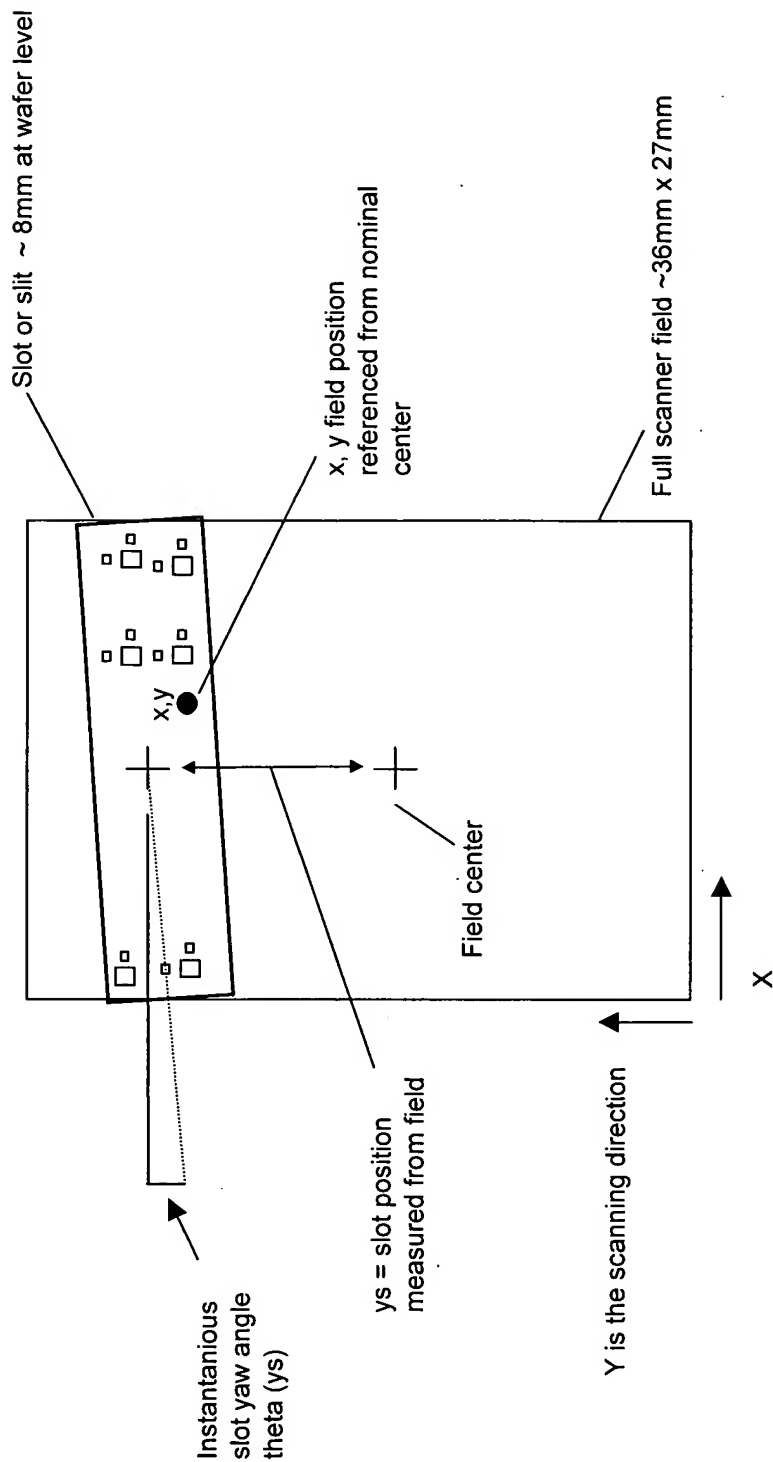


Figure 4a Photolithographic Scanner System



**Figure 4b** Scanner Field and Scanner Slot / Slit Coordinate System



**Figure 5a** Sample Sources Showing Zero Coma Sensitivity ( $dX / da8 = dY / da7 = 0$ )  
 to Large Feature Shift for 248nm and NA = 0.6

1um space/4um pitch  
 400nm resist Threshold model,  
 $E/E_0 = 3$ , focus = 150nm

SOURCE SHAPES IN GENERALLY ACCESSIBLE OR 'PRACTICAL'  
 REGION. PRACTICAL REGION IS  $SIGMA\_O < 0.8$  AND  $0.25 < EPS < 0.75$

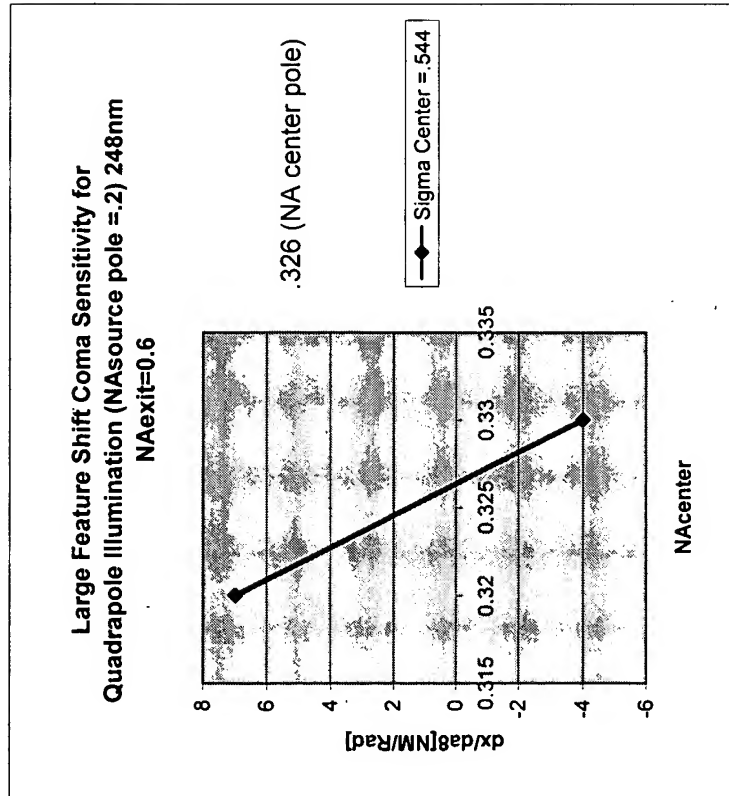
NA = 0.60, LAMBDA = 248NM



EPS = fractional size of hole in source =  $SIGMA\_I / SIGMA\_O$



**Figure 5b** Large Feature Coma Sensitivity for Quadrapole NA=0.6 Sigma Pole Radius =.333



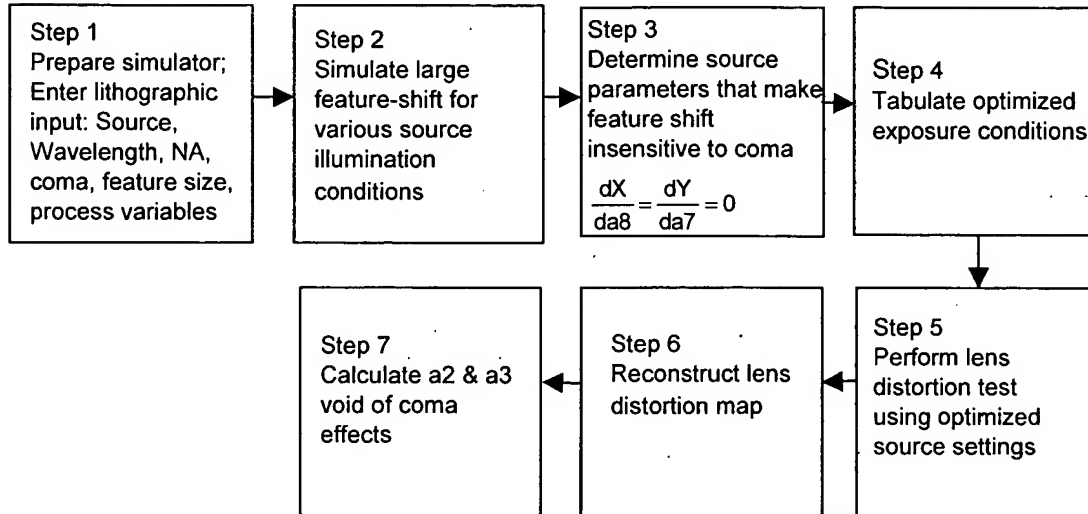
**Figure 6a** Quadrapole Source Shapes Optimized to Reduce the Effects of Coma for Various Wavelengths NA Exit Pupil = 0.6 for a 1um Space/4um Pitch Feature 400nm Resist, Resist Threshold Model, E/E0 = 3, Focus = 150nm

Wavelength	NA exit	NA pole	NA center	Sigma Pole	Sigma Center
365nm	0.6	0.2	0.3270	0.3333	0.5450
248nm	0.6	0.2	0.3263	0.3333	0.5438
193nm	0.6	0.2	0.3232	0.3333	0.5387
157nm	0.6	0.2	0.3189	0.3333	0.5315

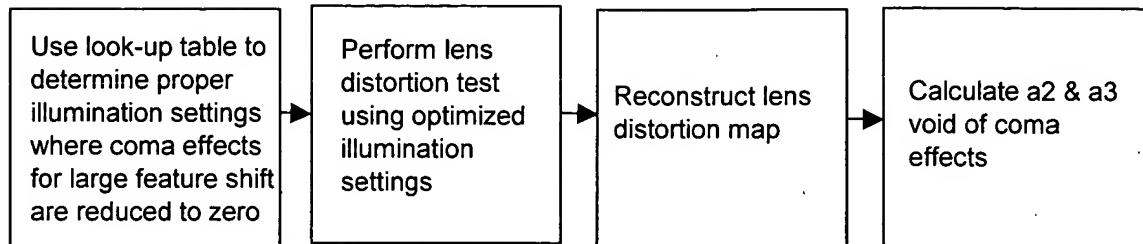
**Figure 6b** Quadrapole Source Shapes optimized to reduce the effects of coma for various wavelengths NA exit pupil = 0.9 for a 1um space/4um pitch 400nm resist, resist threshold model, E/E0 = 3 focus = 150nm

Wavelength	NA exit	NA pole	NA center	Sigma Pole	Sigma Center
365nm	0.9	0.2	0.4995	0.2222	0.5550
248nm	0.9	0.2	0.4818	0.2222	0.5353
193nm	0.9	0.2	0.4725	0.2222	0.5250
157nm	0.9	0.2	0.4719	0.2222	0.5243

**Figure 7a** Process and Application Flow for the Preferred Embodiment Using Simulation

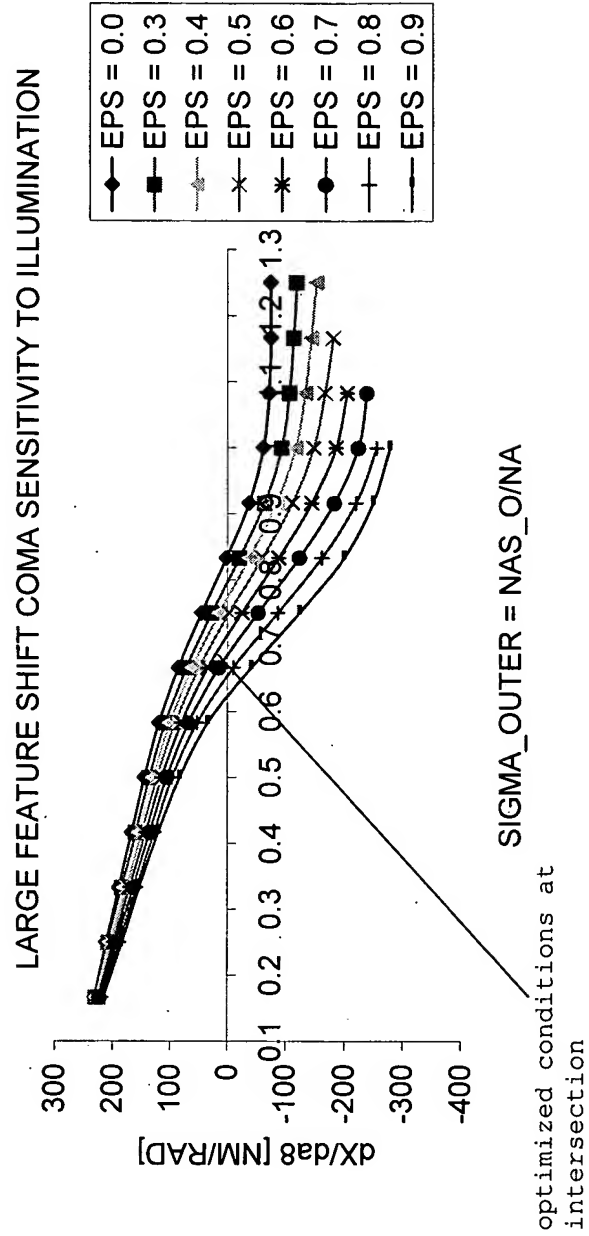


**Figure 7b** Process Flow for Applying the Preferred Embodiment Using Look-Up Tables

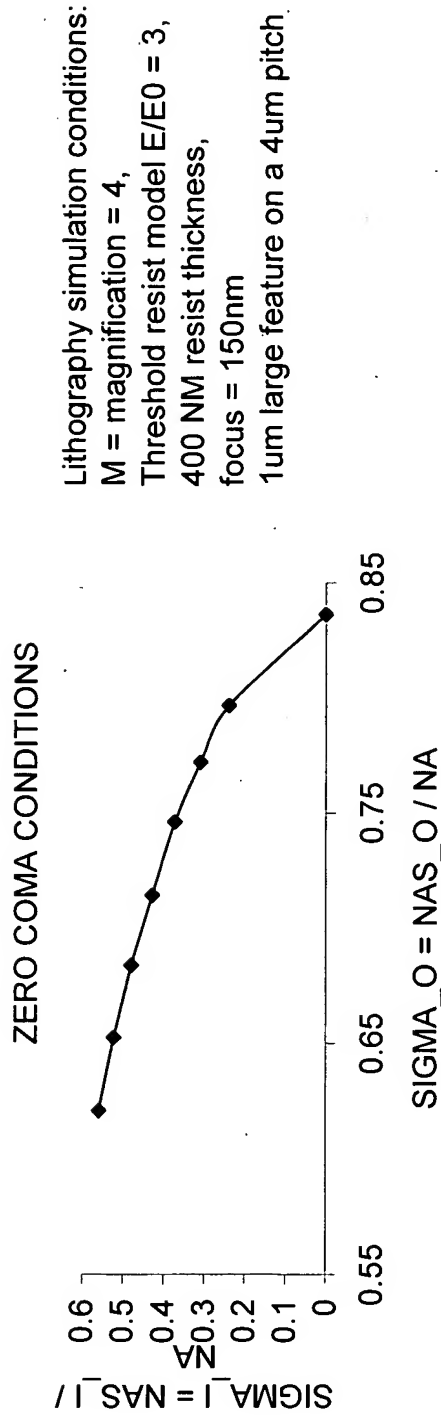


**Figure 8a** Large Feature Sensitivity Plot Showing Coma Coefficient ( $dx/da8$ ) Versus Both Sigma Outer and EPS = Sigma Inner / Sigma Outer for NA = 0.6 and 248nm Simulations

1um space/4um pitch  
 400nm resist, resist threshold  
 model, E/E0 = 3  
 focus = 150nm



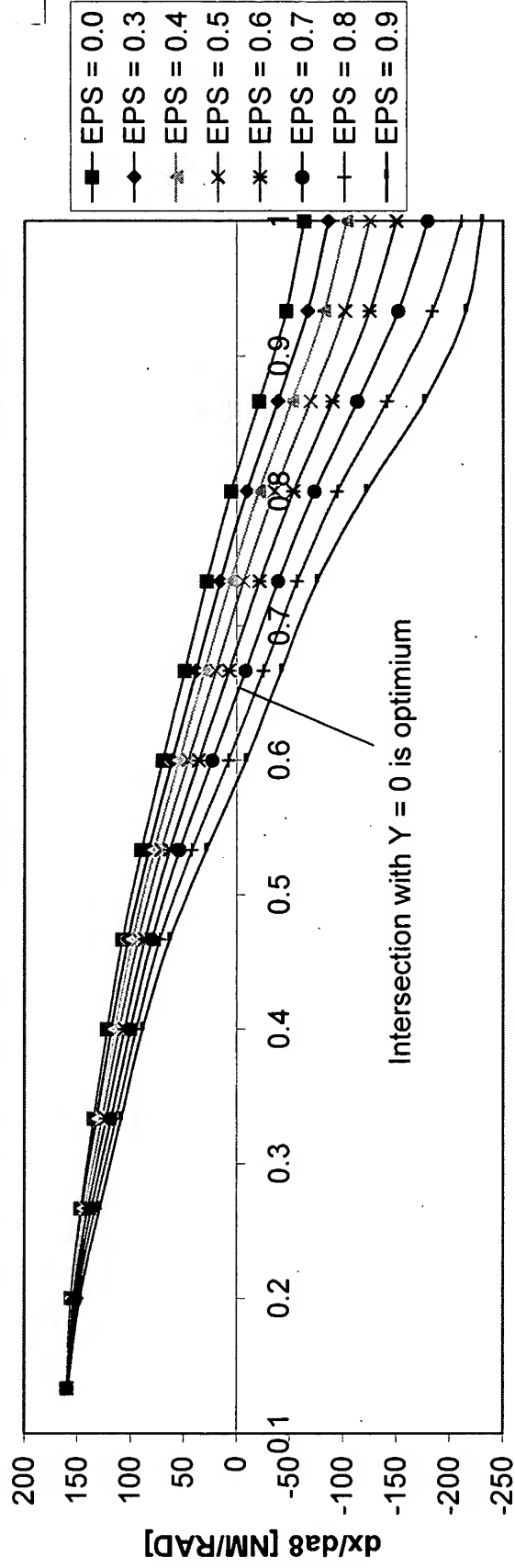
**Figure 8b** 248nm Annular Illumination Optimized Source Settings  
 Showing Sigma Inner vs. Sigma Outer for an NA= 0.6 for a Large  
 Feature



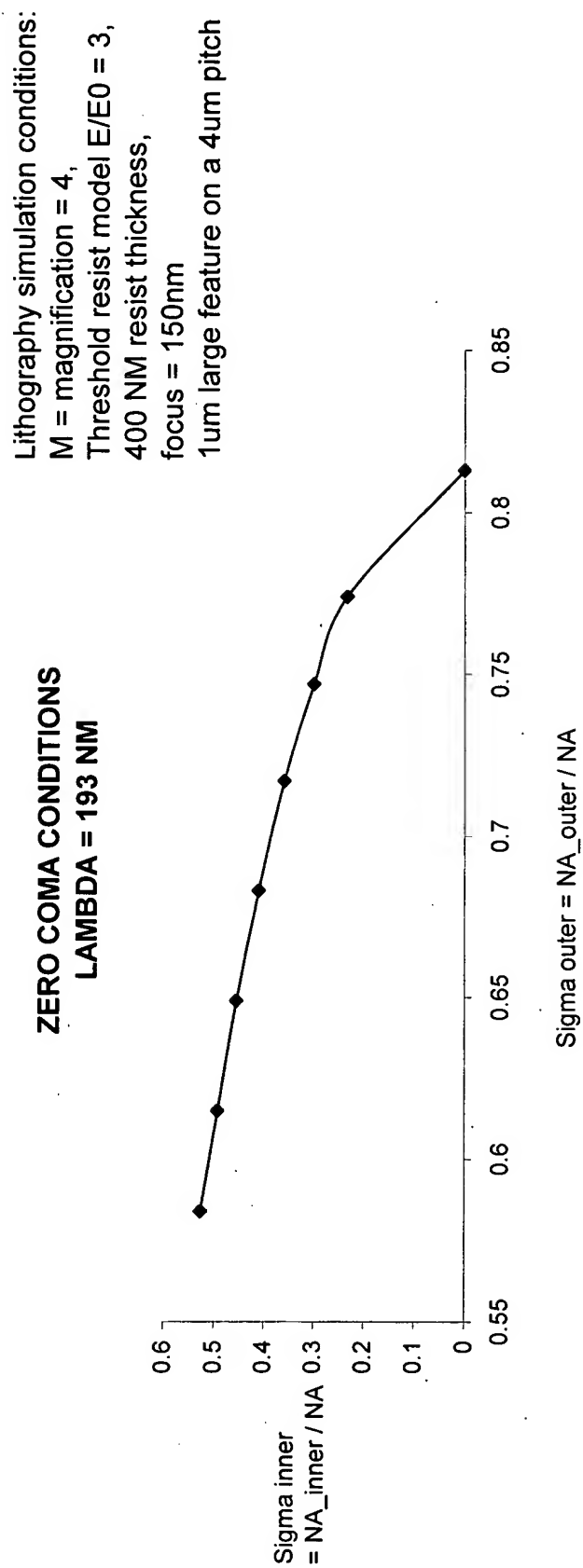
**Figure 9a** Large Feature Sensitivity Plot Showing Coma Coefficient (dx/da8) Versus Both Sigma Outer and EPS = Sigma Inner / Sigma Outer for NA = 0.75 and 193nm Simulations

1um space/4um pitch  
 400nm resist, resist  
 threshold model, E/E0 = 3,  
 focus = 150nm

# LARGE FEATURE SHIFT COMA SENSITIVITY TO ILLUMINATION

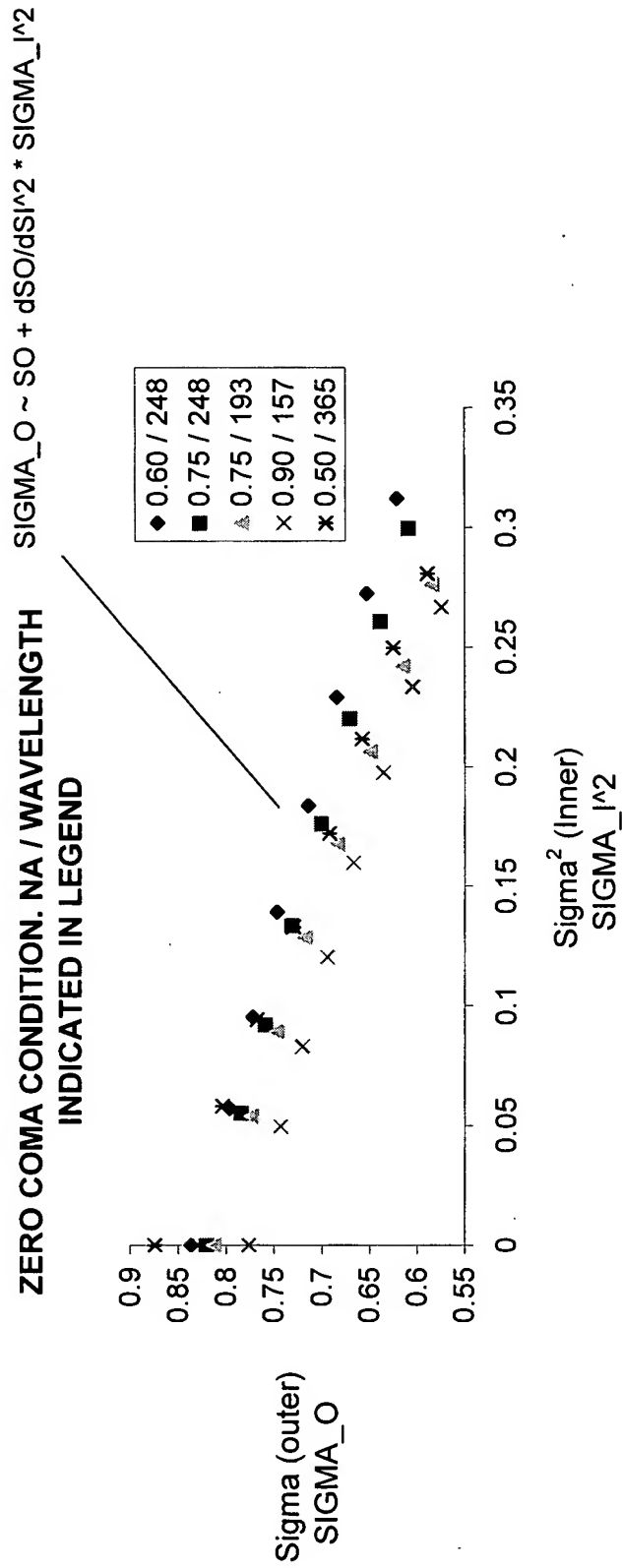


**Figure 9b** 193nm Annular Illumination Optimized Source Settings  
 Showing Sigma Inner vs. Sigma Outer for an NA= 0.75 for a Large Feature

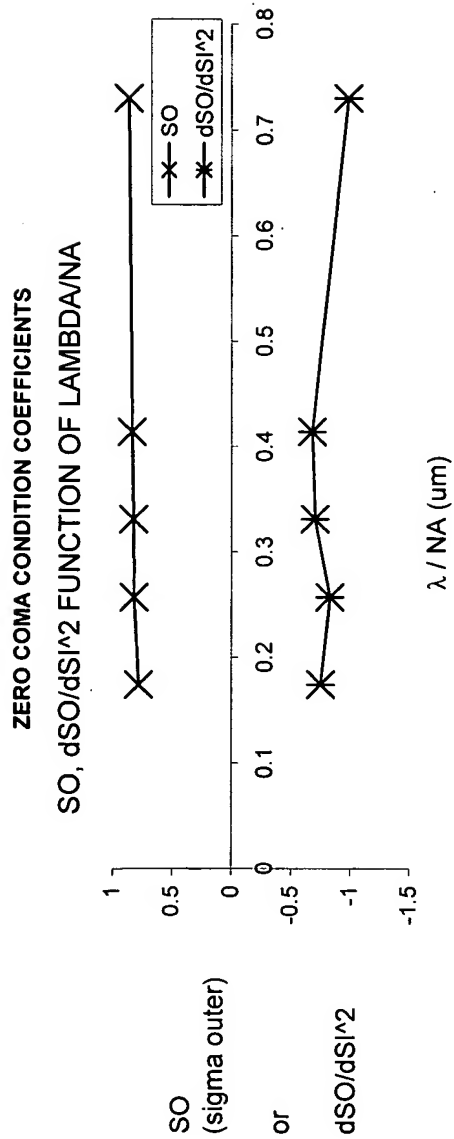




**Figure 10a** Zero Coma Conditions for Different NA / Wavelength Annular Illumination



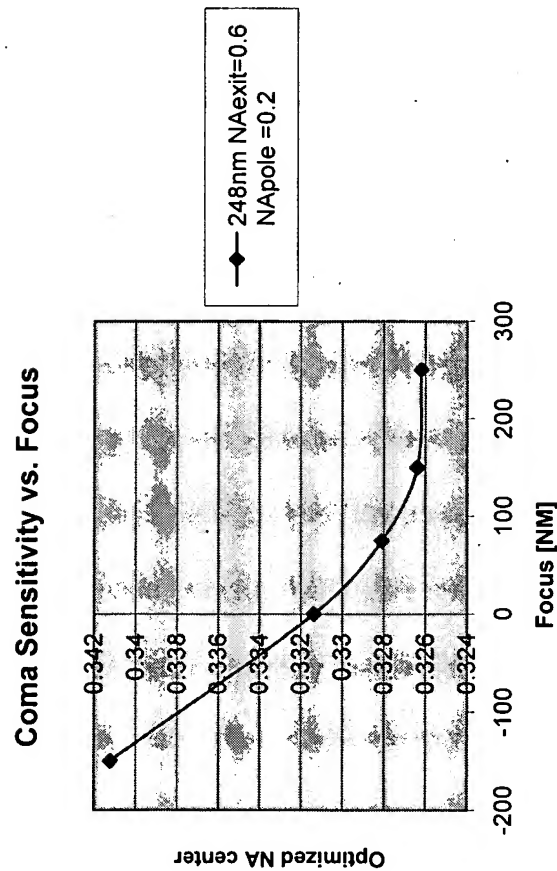
**Figure 10b** A Plot Showing the Fitting Coefficients for Annular Illumination as a Function of Wavelength / NA



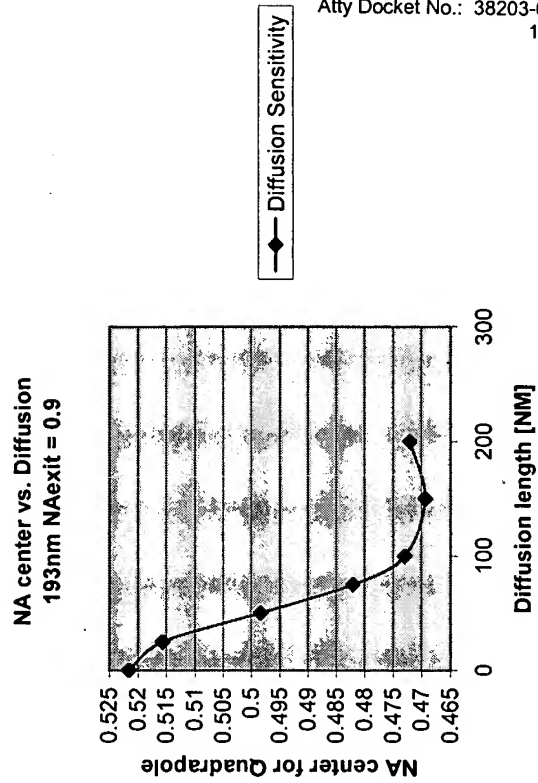
**Figure 10c** A Table Listing the Fitting Coefficients Exhibiting Zero Coma Conditions for Annular Illumination

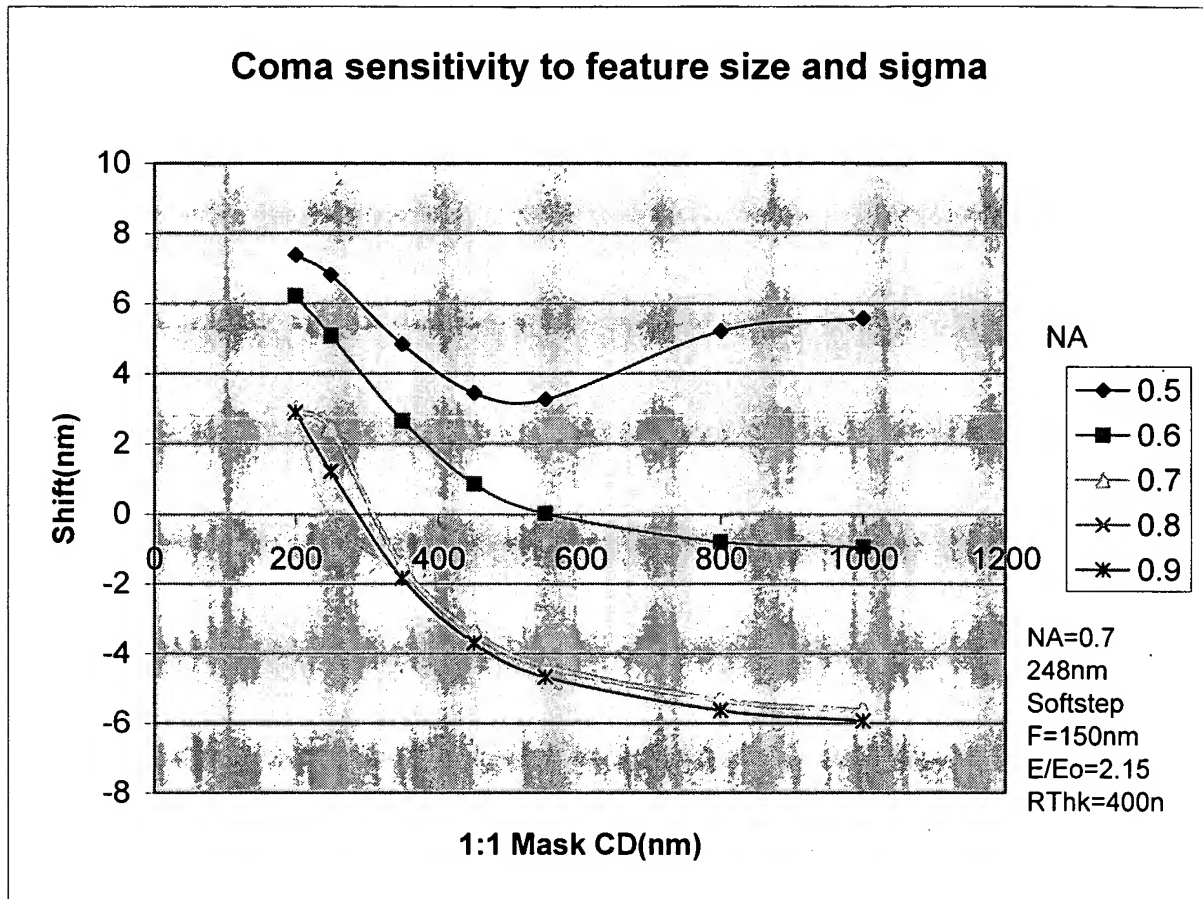
FITTING COEFFICIENTS AS FUNCTION OF $LAMBDA/NA$				
$LAMBDA/NA$ [UM]	$LAMBDA$	NA	SO	$dSO/dSI^2$ RSQ
0.73	365	0.5	0.8652	-0.9867 0.9969
0.413966667	248.38	0.6	0.8375	-0.6808 0.9989
0.331173333	248.38	0.75	0.8233	-0.706 0.9992
0.257333333	193	0.75	0.819	-0.833 0.9974
0.174444444	157	0.9	0.7813	-0.7539 0.9966

**Figure 11a** Optimized Quadrapole Illumination NA Center vs. Focus for Fixed Pole Radius and NA Exit =0.6

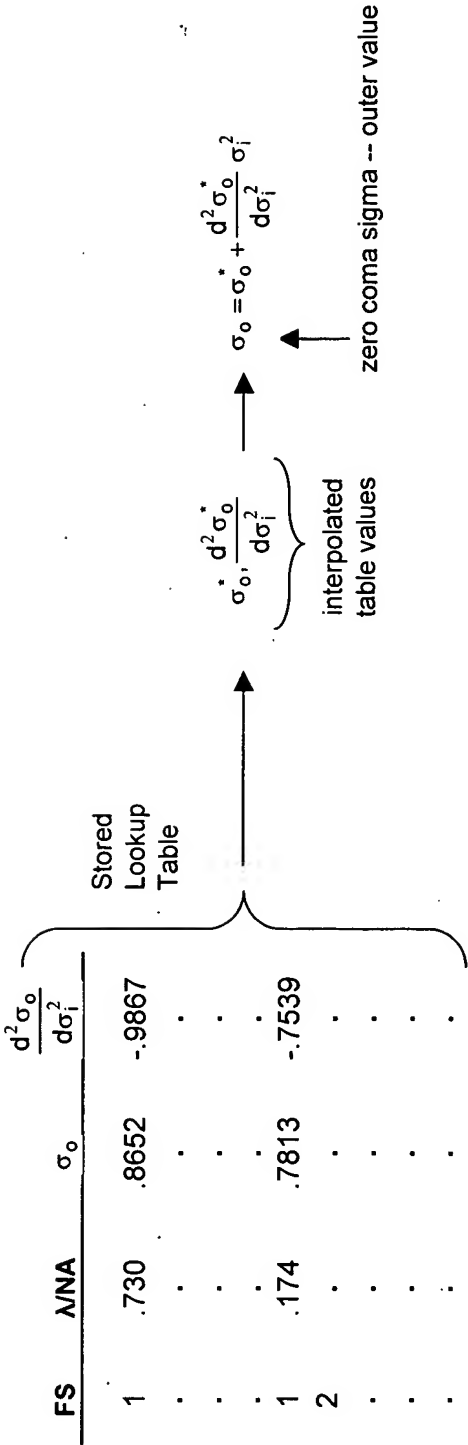


**Figure 11b** Optimized Quadrapole Illumination NA Center vs. Transverse Diffusion

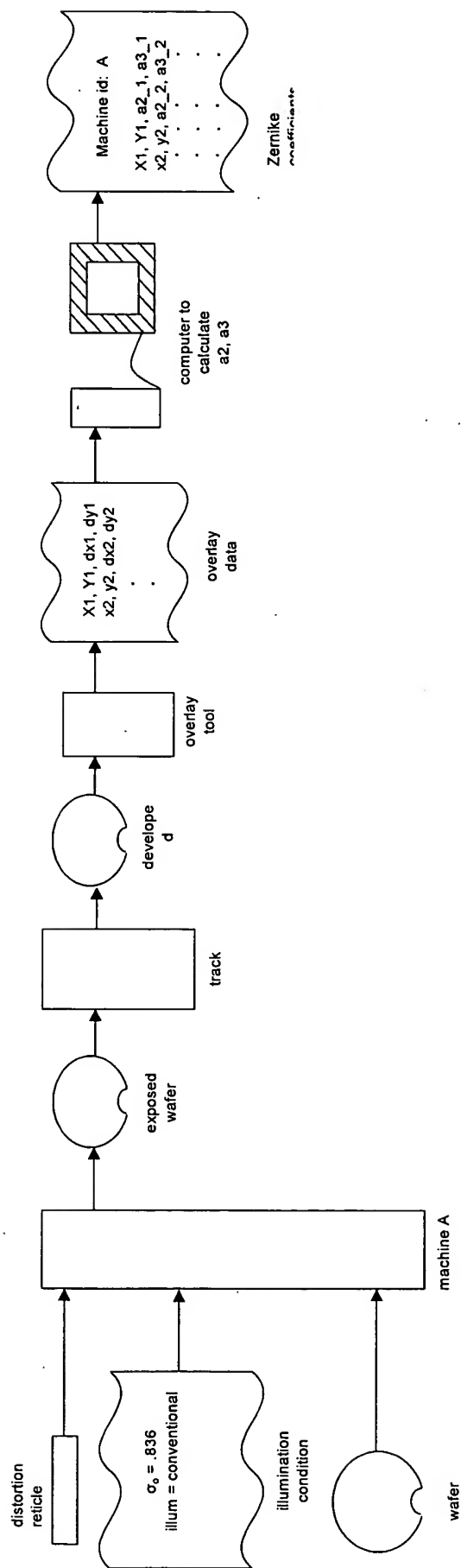




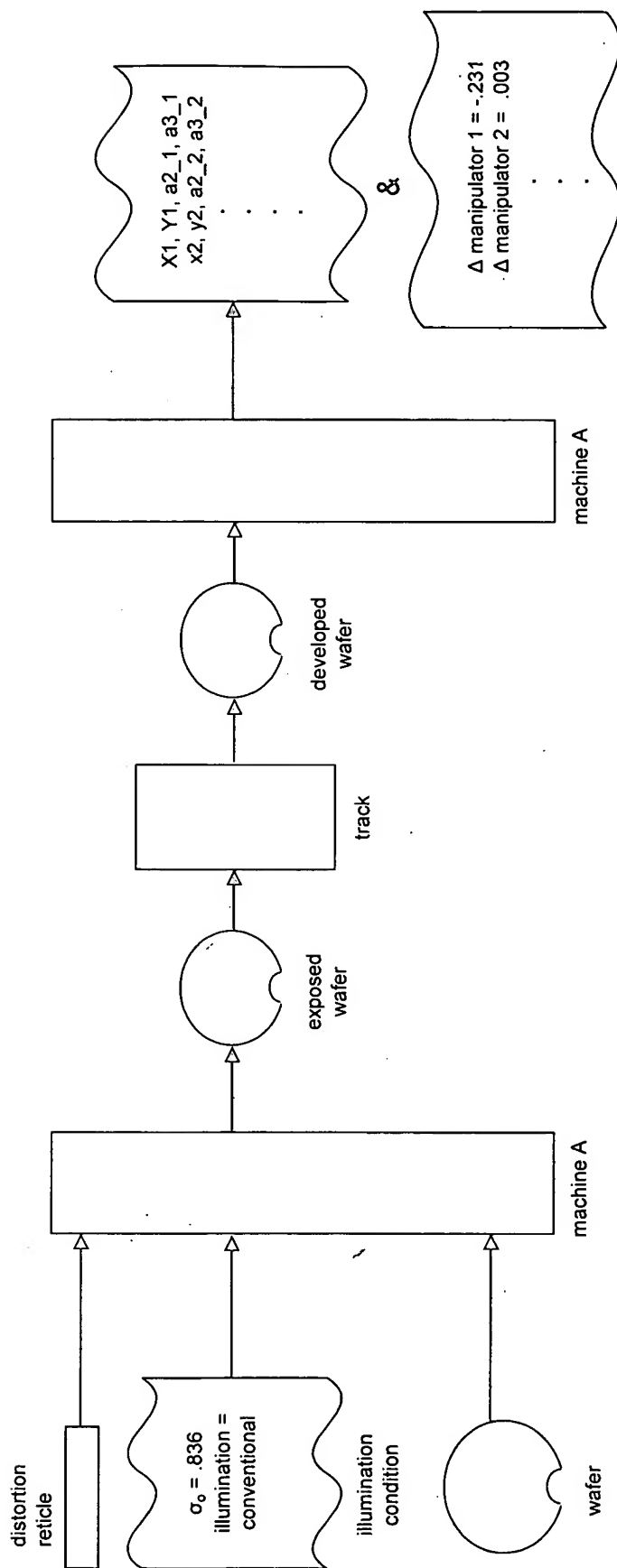
**Figure 12** Coma Shift Sensitivity for Equal Line and Space Features. Curves Labeled by Conventional Source Numerical Aperture ( $NA_s$  or  $NA_{source}$ ).



**Figure 13** Stored Lookup Table and use for Determining Zero Coma Illumination Condition for Conventional or Annular Illumination.



**Figure 14** Schematic of Application of the Method of this Invention to Determining  $a_2, a_3$  in a Lithographic Projection Tool.



**Figure 15** Schematic of Application of the Method of this Invention to Machine Self Determination and Correction of Transverse Distortion.

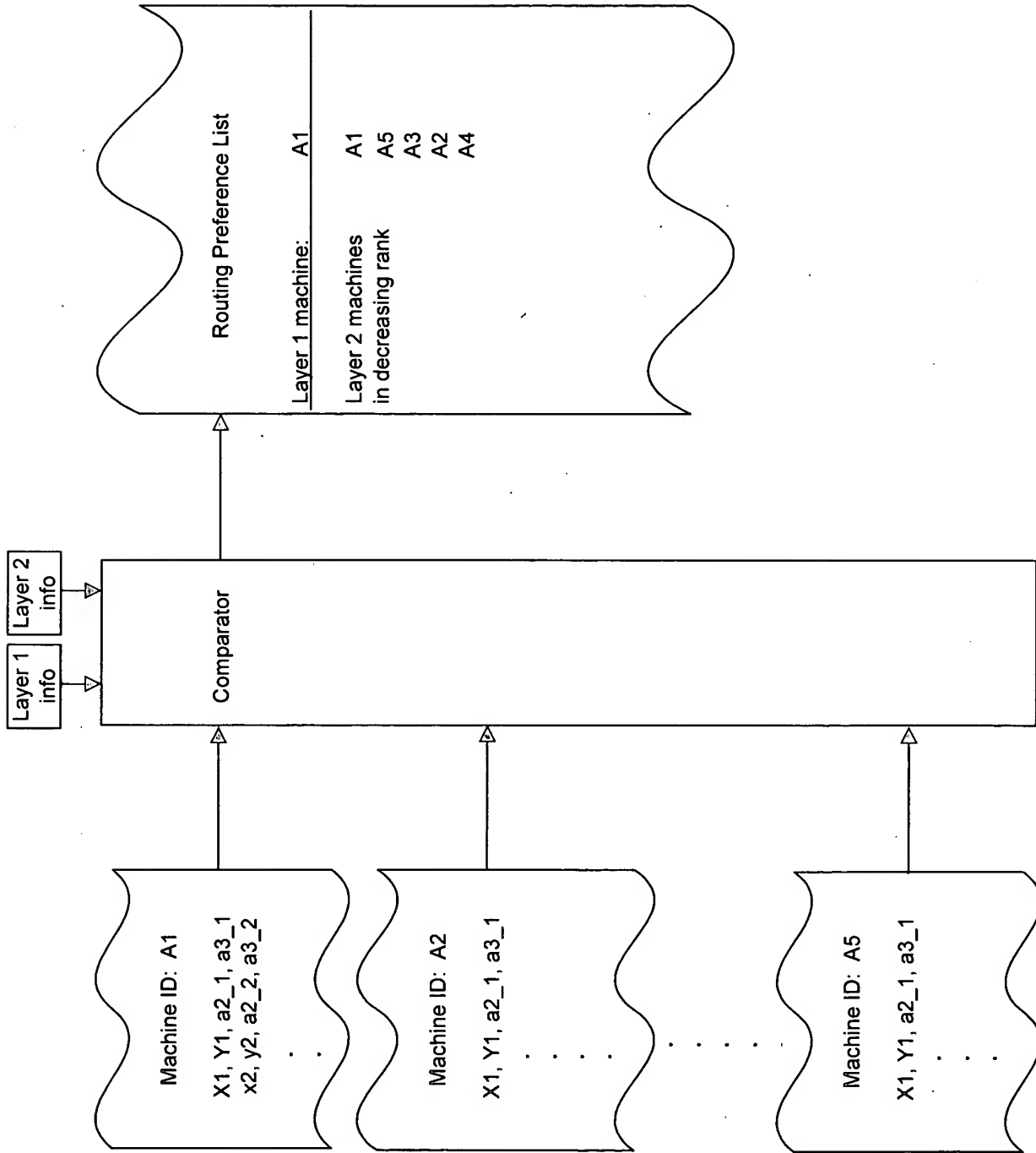


Figure 16 Schematic of Application of the Results of this Invention to Routing Product in a Chip Fab.